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PTO/SB/05 (4/98)
Approved for use through 09/30/2000. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

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UTILITY PATENT APPLICATION TRANSMITTAL

Only for new nonprovisional applications under 37 C.F.R. § 1.53(b)

Attorney Docket No.	
First Inventor or Application Identifier	BOOTH JR, RICHARD A.
Title	CONTROL METHODOLOGY FOR INERTIAL ENERGY STORAGE DEVICES
Express Mail Label No.	

APPLICATION ELEMENTS
See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
Box Patent Application
Washington, DC 20231

- ☒ * Fee Transmittal Form (e.g., PTO/SB/17)
(Submit an original and a duplicate for fee processing)
- ☒ Specification [Total Pages **5**]
(preferred arrangement set forth below)
 - Descriptive title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claim(s)
 - Abstract of the Disclosure
- ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets **1**]
- Oath or Declaration [Total Pages **2**]
 - ☒ Newly executed (original or copy)
 - ☐ Copy from a prior application (37 C.F.R. § 1.63(d))
(for continuation/divisional with Box 16 completed)
 - ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

- ☐ Microfiche Computer Program (Appendix)
- Nucleotide and/or Amino Acid Sequence Submission (if applicable, all necessary)
 - ☐ Computer Readable Copy
 - ☐ Paper Copy (identical to computer copy)
 - ☐ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

- ☐ Assignment Papers (cover sheet & document(s))
- ☐ 37 C.F.R. § 3.73(b) Statement of Attorney (when there is an assignee)
- ☐ English Translation Document (if applicable)
- ☐ Information Disclosure Statement (IDS)/PTO-1449 [Copies of IDS Citations]
- ☐ Preliminary Amendment
- ☐ Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
- ☒ * Small Entity Statement filed in prior application, Status still proper and desired (PTO/SB/09-12)
- ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
- ☐ Other:

* NOTE FOR ITEMS 1 & 13: IN ORDER TO BE ENTITLED TO PAY SMALL ENTITY FEES, A SMALL ENTITY STATEMENT IS REQUIRED (37 C.F.R. § 1.27), EXCEPT IF ONE FILED IN A PRIOR APPLICATION IS RELIED UPON (37 C.F.R. § 1.28).

16. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment:
☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No. _____ / _____
Prior application information: Examiner _____ Group / Art Unit: _____

For CONTINUATION or DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is supplied under Box 4b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

17. CORRESPONDENCE ADDRESS

☐ Customer Number or Bar Code Label

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or ☒ Correspondence address below

Name	RICHARD A. BOOTH JR				
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City	MILWAUKEE	State	WI	Zip Code	53211
Country	USA	Telephone	414-962-2325	Fax	

Name (Print/Type)	RICHARD A. BOOTH JR	Registration No. (Attorney/Agent)	
Signature	<i>[Signature]</i>	Date	1/18/99

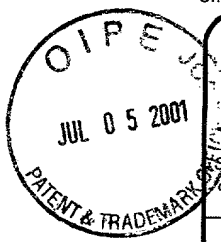
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FEE TRANSMITTAL

Patent fees are subject to annual revision on October 1.
These are the fees effective October 1, 1997.
Small Entity payments must be supported by a small entity statement,
otherwise large entity fees must be paid. See Forms PTO/SB/09-12.
See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT (\$) **380**

Complete if Known

Application Number	
Filing Date	
First Named Inventor	RICHARD A. BOOTH, JR
Examiner Name	
Group / Art Unit	
Attorney Docket No.	

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METHOD OF PAYMENT (check one)

1. ☐ The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

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Deposit Account Name

☐ Charge Any Additional Fee Required Under 37 C.F.R. §§ 1.16 and 1.17 ☐ Charge the Issue Fee Set in 37 C.F.R. § 1.18 at the Mailing of the Notice of Allowance

2. ☒ Payment Enclosed:
☒ Check ☐ Money Order ☐ Other

FEE CALCULATION

1. BASIC FILING FEE				
Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid	
101 790	201 395	Utility filing fee		380
106 330	206 165	Design filing fee		
107 540	207 270	Plant filing fee		
108 790	208 395	Reissue filing fee		
114 150	214 75	Provisional filing fee		
SUBTOTAL (1)			(\$)	380

2. EXTRA CLAIM FEES				
Large Entity Fee Code (\$)	Small Entity Fee Code (\$)	Fee Description	Fee Paid	
103 22	203 11	Claims in excess of 20		
102 82	202 41	Independent claims in excess of 3		
104 270	204 135	Multiple dependent claim, if not paid		
109 82	209 41	** Reissue independent claims over original patent		
110 22	210 11	** Reissue claims in excess of 20 and over original patent		
SUBTOTAL (2)			(\$)	0

FEE CALCULATION (continued)

3. ADDITIONAL FEES					Office
Large Entity Fee Code (\$)		Small Entity Fee Code (\$)		Fee Description	DEPUTY Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	400	216	200	Extension for reply within second month	
117	950	217	475	Extension for reply within third month	
118	1,510	218	755	Extension for reply within fourth month	
128	2,060	228	1,030	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,320	241	660	Petition to revive - unintentional	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	670	244	335	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	790	246	395	Filing a submission after final rejection (37 CFR 1.129(a))	
149	790	249	395	For each additional invention to be examined (37 CFR 1.129(b))	
Other fee (specify) _____					
Other fee (specify) _____					
Reduced by Basic Filing Fee Paid					
SUBTOTAL (3) (\$)					0

OFFICE OF PETITIONS
DEPUTY A/C PATENTS

SUBMITTED BY

Typed or Printed Name	RICHARD A. BOOTH, JR			Complete (if applicable)	
Signature	<i>[Signature]</i>			Reg. Number	
Date	1/8/99	Deposit Account User ID			

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**STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(b))--INDEPENDENT INVENTOR**

Docket Number (Optional)

Applicant, Patentee, or Identifier:

RICHARD A. BOOTH, JR.

Application or Patent No.:

Filed or Issued:

Title: CONTROL METHODOLOGY FOR INERTIAL ENERGY STORAGE
DEVICES

As a below named inventor, I hereby state that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees to the Patent and Trademark Office described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

I have not assigned, granted, conveyed, or licensed, and am under no obligation under contract or law to assign, grant, convey, or license, any rights in the invention to any person who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9(d) or a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☒ No such person, concern, or organization exists
☐ Each such person, concern, or organization is listed below.

Separate statements are required from each named person, concern, or organization having rights to the invention stating their status as small entities. (37 CFR 1.27)

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

RICHARD A. BOOTH, JR.

NAME OF INVENTOR

NAME OF INVENTOR

NAME OF INVENTOR

Signature of inventor

Signature of inventor

Signature of inventor

Date

Date

Date



TITLE

Control Methodology for Inertial Energy Storage Devices

BACKGROUND OF THE INVENTION

Regulation of stored energy is essential to most machinery. Various forms of energy storage are in common usage (e.g. chemical, elastic, pneumatic). The control of power flow from inertial energy storage means has proven to be more difficult than from other forms.

Storage of energy by means of inertial energy advanced during the 1980's and 1990's through development of flywheels made from aerospace materials, rotating in near total vacuum and supported on magnetic bearings. Such devices can have energy densities equal to or greater than lead acid storage batteries.

Electrical power backup systems employing such advanced flywheels with an integral motor / generator have been commercialized. The motor function of the electrical power backup system motor / generator drives the flywheel to optimal storage speed when the normal electrical power source is available. The generator function supplies back-up electricity in the case of power outages drawing power from the flywheel.

The electrical power backup system motor / generator need not operate at a specific speed because alternating current of a specific frequency, if required, is maintained with electrical circuitry during backup power generation. The motor / generator therefore spins at a fixed ratio to instantaneous flywheel speed (not a multiple of the alternating current frequency).

Variable speed machinery that must operate at a specific speed in a specific condition (for example a vehicle) requires a control mechanism to accommodate the speed difference between the machinery and the (inherently variable speed) inertial energy storage device.

The application of a continuously variable transmission [CVT] or infinitely variable transmission [IVT] to variable speed machinery is obvious. Control of the power flow through a CVT to machinery that incorporates an inertial energy storage means has been the subject of previous patents. For example, in U.S. patent number 3672244 Mr. Nasvytis describes a "foot pedal ... connected to said [infinitely variable] transmission means to decrease the ratio of the transmission upon depression of the foot pedal and increase the ratio upon release of the foot pedal". The CVT is controlled directly by operator input and there is no feedback.

In cases where the CVT speed ratio is controlled directly by an operator, as with the Mr. Nasvytis' foot pedal, the CVT control position is the operator's input for speed ratio. The *rate of change* of the CVT ratio is the acceleration input. For machinery in which the CVT ratio can change more rapidly than the machinery can accelerate, the operator must be skilled at not changing the ratio at a rate greater than the machinery can tolerate. The

limitation to acceleration of the machinery will in most cases be slippage or breakage. Using an automobile for an example, the limit to acceleration is slippage of the tires; tires would slip if the speed control were changed too quickly.

In the event that the *rate of change* of the CVT ratio frequently exceeds the acceleration capability of the machinery, even momentarily, and causes slippage, energy is wasted, which is counter to the original goal of using inertial storage.

Operators of machinery need precise control of acceleration in addition to the ability to set speed. A wide variety of machinery is either powered by a combustion engine, controlled with friction braking, or both. Throttle position determines the force (torque) and therefore acceleration of the machinery. Friction braking controls force and therefore deceleration.

Due to the difficulty in controlling acceleration via rate of controller actuation, the predominance of force application controls or the energy wasted due to slippage, direct CVT control of machinery utilizing a inertial energy storage device has not been widely implemented.

An alternative to CVT control has been to utilize two motor / generators (both similar to the backup electrical power system). One motor / generator operates at the same speed as the inertial energy source, the second at the same speed as the machinery. Energy flow is regulated electrically. This system was employed in a concept vehicle developed by Rosen Motors and described in *Time Magazine*, September 23, 1996.

The cost of two motor / generator units in the two motor / generator system is a drawback of this system. Additionally, electrical motors and conductors sized to supply peak power will have relatively high electrical resistance losses at low power flows.

The prior art for control of power flow from a inertial energy source includes the utilization of a clutch or clutch systems. The clutches accommodate the speed difference between the machinery and a inertial energy storage device and regulate the power flow to and from machinery from an inertial energy storage system.

Representative of clutch systems is the teaching of Mr. Smitley in U. S. Patent 4342371. Two over-running clutches, one for forward rotation and one for reverse rotation, may be selectively engaged to transmit power to a storage flywheel through corresponding forward and reverse rotating magnetic clutches. Some slippage of the magnetic clutches is anticipated.

The drawback of clutch systems, whether frictional or magnetic, is that slippage will dissipate energy that could, in the absence of slippage, be transmitted to the machinery or stored in the flywheel.

BRIEF SUMMARY OF THE INVENTION

The present invention is a control methodology for an inertial energy storage device that utilizes a continuously variable transmission [CVT]. The CVT ratio is a function of an error signal equal to the difference between operator input and CVT output torque.

This methodology continuously synchronizes the speeds of the inertial energy storage device and powered machinery, keeping frictional losses to a minimum.

Operator input may be a positive or a negative value, a negative value corresponding to regenerative power. Operator input is force or torque analogous to throttle opening or braking effort.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The present invention is shown schematically in Figure 1. The inertial energy storage means 1 is coupled directly to the machinery 3 through CVT 2. Elasticity between the CVT 2 and machinery 3 is shown in Figure 1 as spring 4.

Figure 2 is a block diagram using the Laplace variable "s" representing an embodiment of the present invention in which the CVT ratio is equal to the time integral of an error signal.

Block diagram Figure 3, also using the Laplace variable "s", represents an embodiment of the present invention in which an additional feedback loop is incorporated.

DETAILED DESCRIPTION OF THE INVENTION

The present invention is a control methodology for a inertial energy storage device that utilizes a continuously variable transmission [CVT]. Control of the CVT speed ratio is based on feedback of the CVT output torque. With this control methodology, the operator inputs force or torque just as with an engine or brake. The methodology employs no clutches or other slipping mechanisms and therefore dissipates only the hysteretic losses in metallic elastic structural elements, including the CVT.

The present invention is shown schematically in Figure 1. The inertial energy storage means 1 is coupled directly to the machinery 3 through CVT 2.

Advantage is taken of the inherent elasticity of the coupling shafts. If however, inherent elasticity is insufficient for control purposes, a discrete spring may also be included in the system between CVT 2 and machinery 3. This elasticity, whether inherent or discrete, is shown schematically in Figure 1 (and referred to herein) as spring 4.

Referring to Figure 1 the output speed of the CVT, V_2 , is equal to the speed of the inertial energy storage means times the instantaneous CVT speed ratio, $V_1 * R$. At equilibrium the average CVT output speed V_2 must equal the average machinery speed V_3 . At any

time V_2 is greater than V_3 deflection of spring 4 will increase thereby increasing the force acting across spring 4 in proportion to the stiffness of spring 4. (Force decreases when V_2 is less than V_3 with the sign convention that negative force decelerates machinery 3.)

In the present invention the CVT speed ratio is increased or decreased as a function of either the measured deflection of spring 4, or the measured force across spring 4.

In a physical system a clutch in series with the CVT may be included to completely disengage the machinery from the inertial energy storage means when the machinery is either at rest or at a speed in excess of the capability of the CVT. However, the clutch is not considered to be a component of the power regulation control system. The clutch does not slip in normal operation, although it may be engineered to act as a force or torque limiter.

In a physical system a fixed ratio transmission in series with the CVT may be included to allow the CVT to operate in the design speed range of the CVT. A fixed ratio transmission may also provide "reverse" capability for the machinery. However, the fixed ratio transmission is not considered to be a component of the power regulation control system.

Control system dynamics are analyzed using block diagrams and the Laplace variable. This method is most useful when the control system is linear or can be linearized.

A CVT can be represented mathematically by multiplication of a ratio times an input speed. Multiplication is extremely nonlinear invalidating block diagram analysis. However, the control system block diagram can be used to illustrate the control methodology of the present invention.

Block diagram Figure 2 represents an embodiment of the present invention in which the CVT ratio is equal to the time integral of an error signal ($1/s$ in the Laplace domain). The error signal is the difference between operator input force and the force in spring 4, labeled F_4 . With initial conditions of V_2 not equal to V_3 , this control system will synchronize V_2 with V_3 after a number of oscillations. The error signal becomes zero when the spring force equals the input force, in which case the time integral (which is the CVT ratio) remains constant.

The time integral in the embodiment represented by figure 2 is *not* classic P-I Proportional – Integral feedback.

Block diagram Figure 3 represents an embodiment of the present invention in which an additional feedback loop is incorporated. In the absence of operator input or force in spring 4 CVT ratio R is V_3 / V_1 such that $V_2 = V_3$. With operator input, spring force increases until the spring force equals the operator input, in which case the error signal is zero and once again $V_2 = V_3$.

In the second embodiment the error signal feedback behaves similarly to feedback elements in a linear controls systems despite the non-linear nature of the CVT. Proportional, Proportional – Integral (P-I) feedback, Classical Proportional – Integral – Derivative (P-I-D) feedback or other well understood methods may be applied to achieve desired control.

CLAIMS:

1. A control methodology for regulating the power input and output of a inertial energy storage device, such as a flywheel. The control methodology utilizes a continuously variable transmission [CVT] and comprises control of the CVT speed ratio based on feedback of the CVT output force or torque
2. A control methodology for regulating the power input and output of a inertial energy storage device, such as a flywheel, as in claim 1 in which the CVT ratio is equal to the time integral of an error signal derived from operator input and feedback of a signal proportional to CVT output torque.
3. A control methodology for regulating the power input and output of a inertial energy storage device, such as a flywheel, as in claim 1 in which the CVT ratio is equal to a ratio - measured speed of the machinery divided by measured speed of the inertial energy storage device - plus an error signal derived from operator input and feedback of a signal proportional to CVT output torque

ABSTRACT of the DISCLOSURE:

A control methodology for regulating the power input and output of a inertial energy storage device, such as a flywheel. The control methodology utilizes a continuously variable transmission [CVT] and comprises control of the CVT speed ratio based on feedback of the CVT output torque.

Two embodiments are detailed. For both embodiments the CVT ratio is a function of an error signal equal to the difference between operator input and CVT output torque. Operator input may be a positive or a negative value, a negative value corresponding to regenerative power. Operator input is force or torque analogous to throttle opening or braking effort.

This methodology continuously synchronizes the speeds of the inertial energy storage device and powered machinery, keeping frictional losses to a minimum.

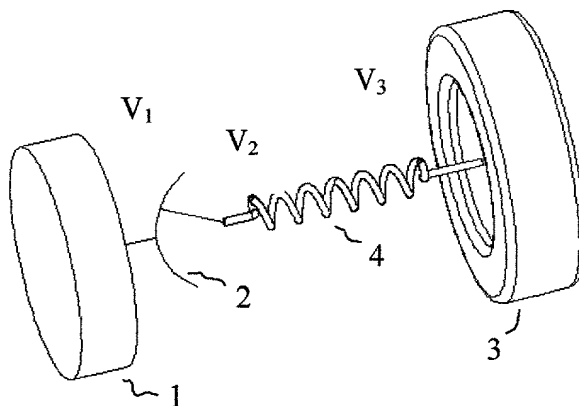


Figure 1

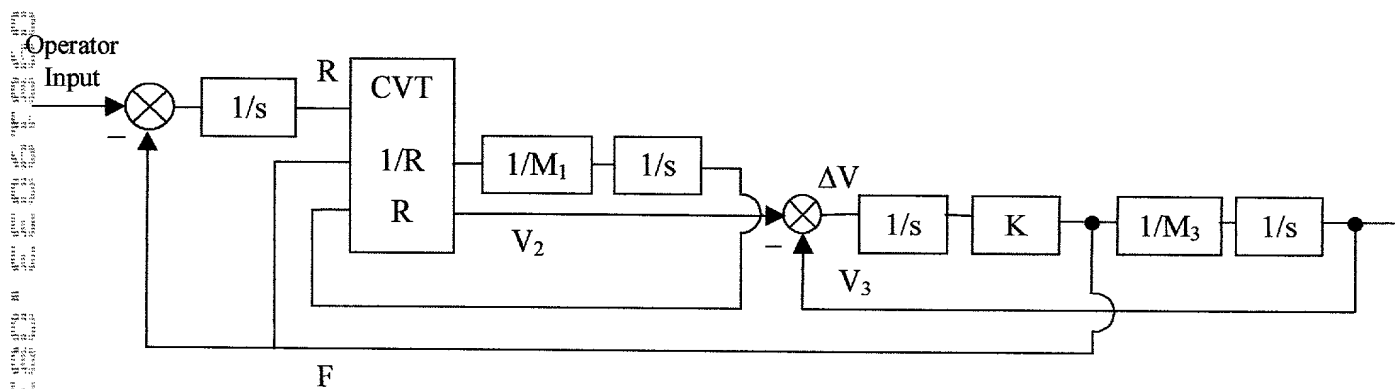


Figure 2

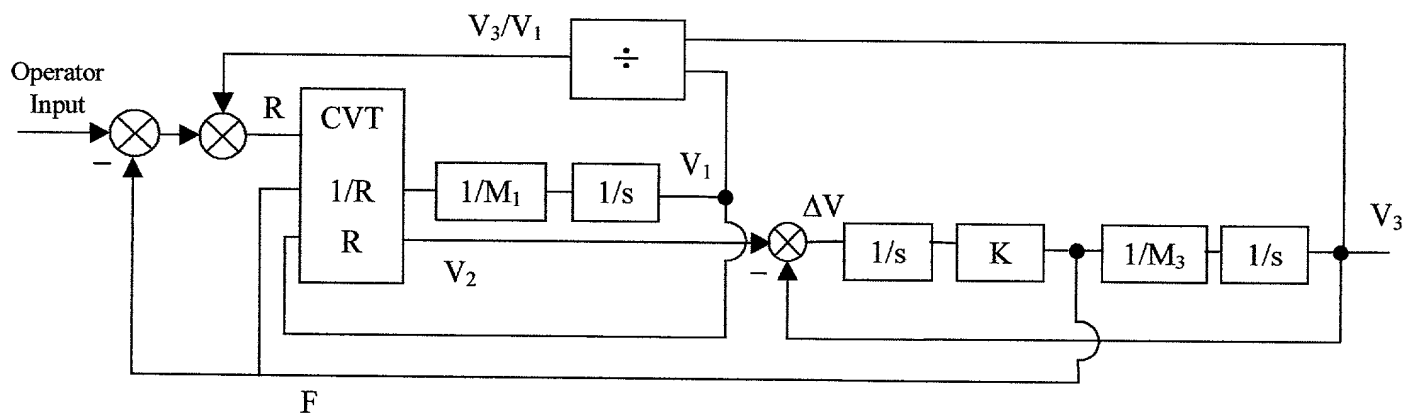


Figure 3

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Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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**DECLARATION FOR UTILITY OR
DESIGN
PATENT APPLICATION
(37 CFR 1.63)**

☐ Declaration Submitted with Initial Filing OR ☐ Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)

Attorney Docket Number

First Named Inventor

Booth, Jr.; Richard A

COMPLETE IF KNOWN

Application Number

Filing Date

Group Art Unit

Examiner Name

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OFFICE OF PETITIONS
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As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

CONTROL METHODOLOGY FOR INERTIAL ENERGY
STORAGE DEVICES

the specification of which (Title of the Invention)

☒ is attached hereto

OR

☐ was filed on (MM/DD/YYYY) as United States Application Number or PCT International

Application Number and was amended on (MM/DD/YYYY) (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?	
				YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

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DECLARATION — Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

☐ Customer Number

OR

☐ Registered practitioner(s) name/registration number listed below

Place Customer Number Bar Code Label here

Name	Registration Number	Name	Registration Number

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☐ Customer Number or Bar Code Label ☒ Correspondence address below

Name	RICHARD A. BOOTH, JR.				
Address	4372 N. WILDWOOD AVE				
Address					
City	MILWAUKEE,	State	WI	ZIP	53211
Country	USA	Telephone	414-962-2325	Fax	

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:		<input type="checkbox"/> A petition has been filed for this unsigned inventor	
Given Name (first and middle [if any])		Family Name or Surname	
RICHARD A.		BOOTH, JR	
Inventor's Signature	Date		11/18/99
Residence: City	MILWAUKEE	State	WI
	Country	53211	Citizenship
Post Office Address	4372 N. WILDWOOD AVE		
Post Office Address			
City	MILWAUKEE	State	WI
	ZIP	53211	Country
			USA

☐ Additional inventors are being named on the supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto